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(56) Documents cited
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INT CL[5] E21B

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(54) Downhole assembly

(57) A downhole assembly for positioning a device (26), such as a measuring device, within a drill string (10) comprises a hang-off means (32) for securement in an upper drill string member, a lower connector means (22) for location in a lower drill string member (20), and means (30) interconnecting the hang-off means and the lower connector means. The device (26) is mounted on the interconnecting means (30), and the interconnecting means (30) including a shock absorber device (28) connected between the device (20) and the hang-off means (32). Also provided is apparatus for use in determining the alignment of the inner barrel of a core barrel assembly comprising a laser, means for rotatably mounting the laser on the inner core barrel with the axis of the laser parallel to the axis of the core barrel assembly, means for clamping said rotatable mounting means in a desired angular position, and a target arm adapted to be mounted on the end of the assembly distant from the core barrel to intercept the laser beam.

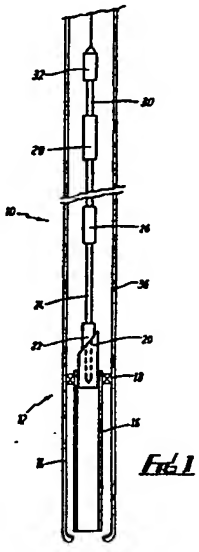

Fig 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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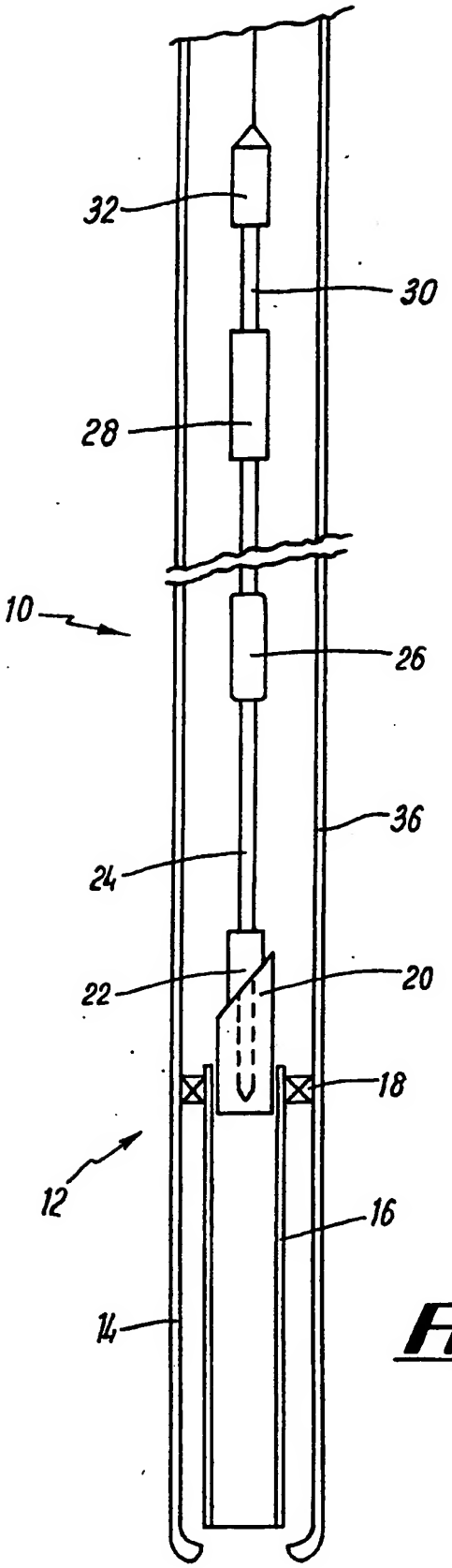


FIG. 1

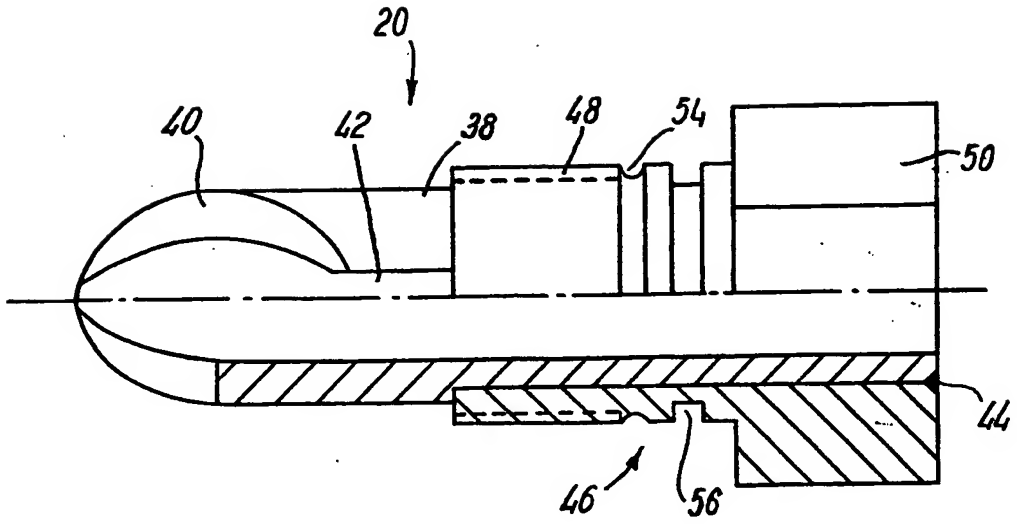


FIG. 2

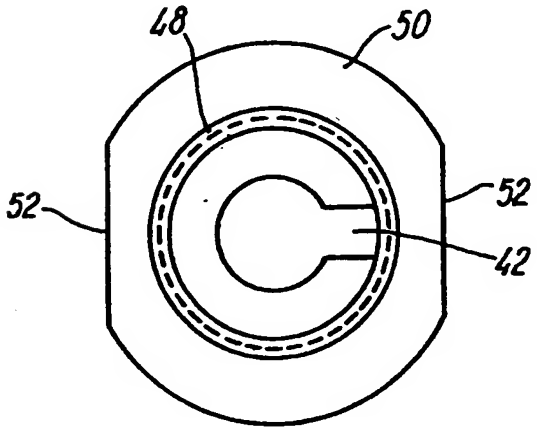


FIG. 3

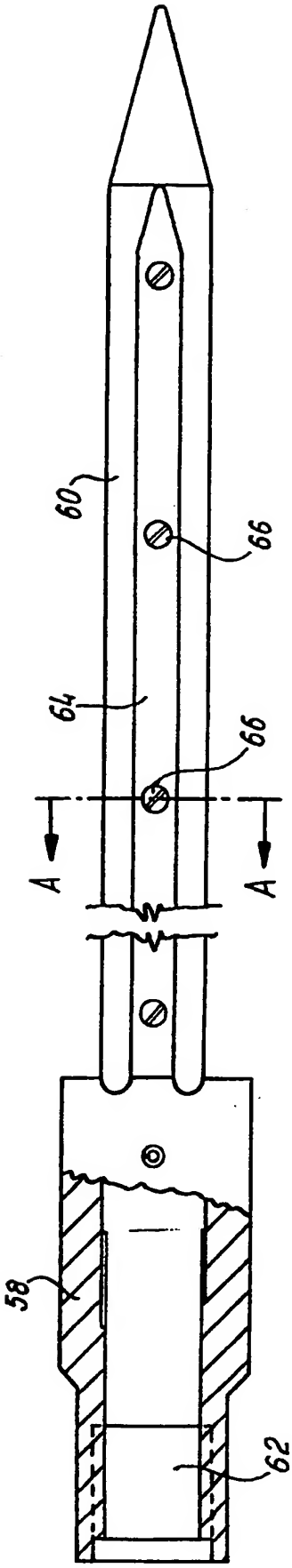


FIG. 4

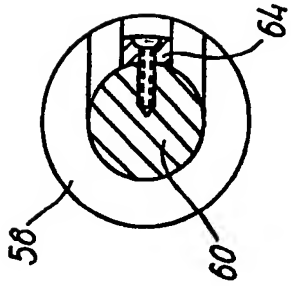


FIG. 5

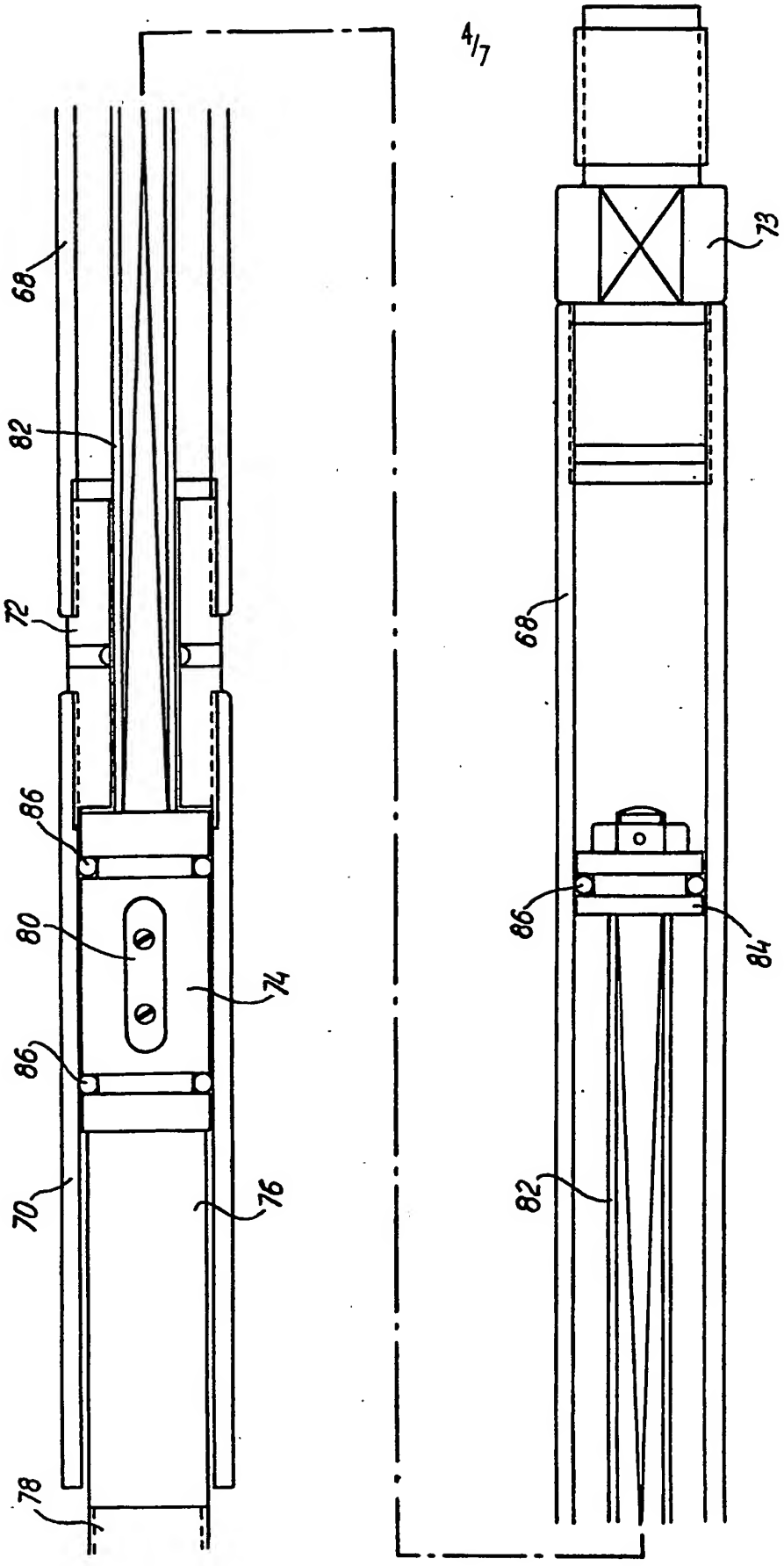
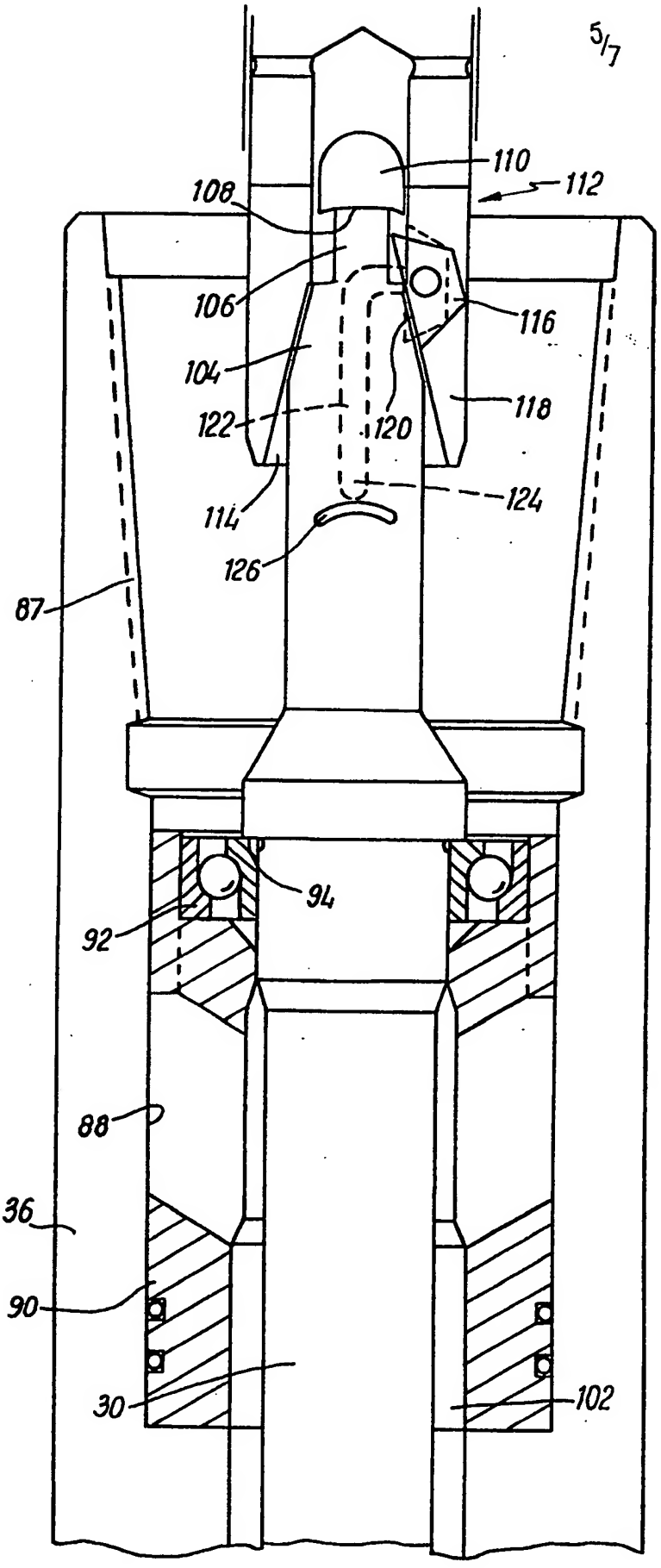


FIG. 6


110
112
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102

FIG. 1

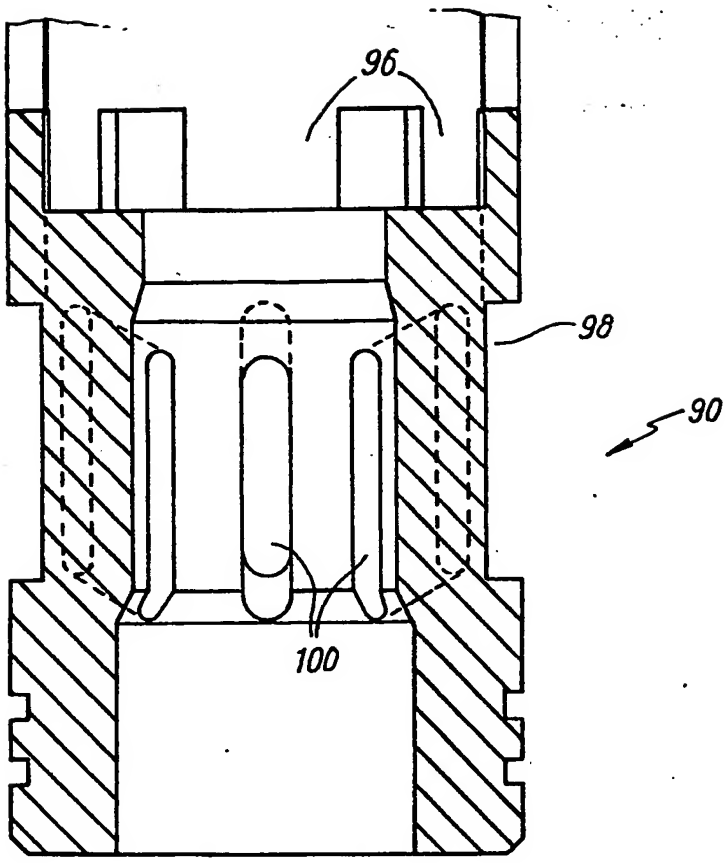
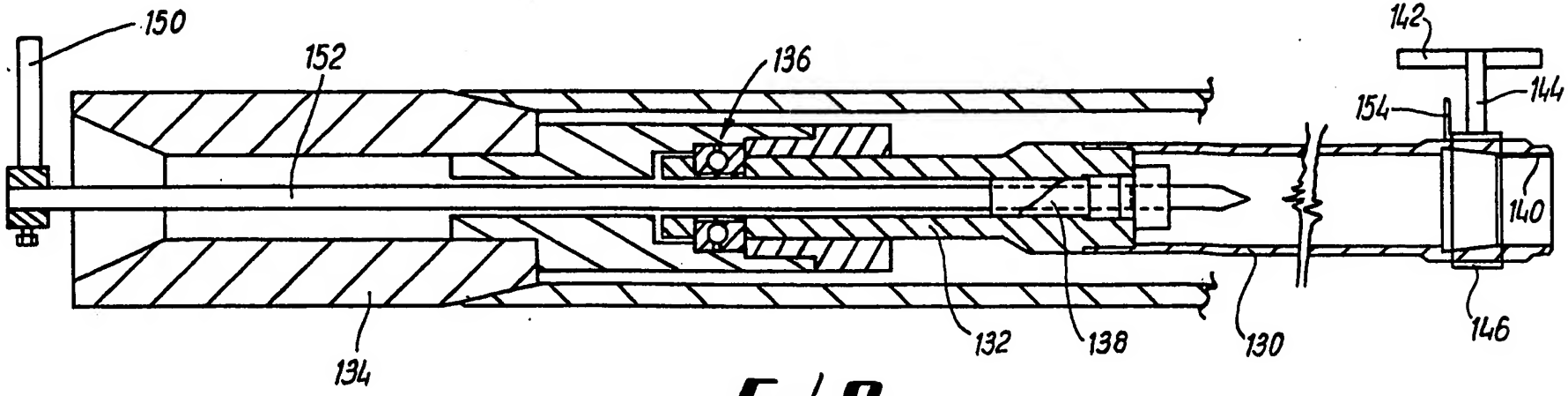


FIG. 8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154
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138
132
134

FIG. 9

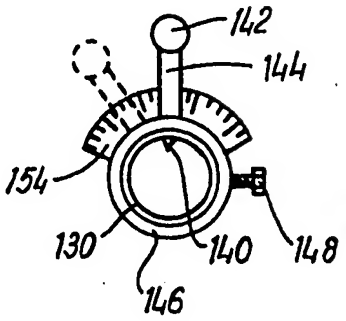
142
144
154
130
140
148
146

FIG. 10

Downhole Assembly

This invention relates to a downhole assembly for positioning a desired device within a drill string. The invention is particularly, but not exclusively, concerned with the case where the device comprises one or more electronics packages used for measuring borehole parameters.

It is known to run a downhole assembly in which electronics packages are mounted on an axial rod which carries at its lower end a stinger which locates in a mule shoe secured to a section of drill pipe. The upper end of the rod is carried in use by a bearing or other hanger means secured to an upper drill collar.

This known arrangement has a number of disadvantages. One is that shock loadings and vibrations of the drill bit are transmitted through the drill string, mule shoe, stinger and rod to the electronics packages, leading to unacceptably poor reliability. Another is that when the assembly is run into position the engagement with the bearing or hanger subjects the electronics packages to a shock load. Further, the bearing or hanger arrangements presently in use do not permit the assembly to be disconnected and

removed wthout pulling the drill string from the borehole.

Downhole assemblies as discussed above are typically used in investigations in which rock cores are removed, and the lower part of the assembly comprises a core barrel for this purpose. It is necessary to know the original orientation of the cores when these are examined. It is usual to provide scribing blades or knives within the entrance of the core barrel, which mark the outer surface of the cores with distinctive score lines identifying the orientation. For this to be effective, however, it is necessary for the operator at the drilling platform to know the orientation of the core barrel relative to the hole when the core barrel engages the formation. In the past, this has been achieved by sighting by eye along each length or stand of drill pipe as it is engaged in the string. This tends to be subject to angular error of a few degrees as each extra length is added, and these errors can accumulate to a significant overall error by the time the core barrel reaches bottom.

An object of the present invention is to provide a downhole assembly which overcomes or mitigates one or more of these problems.

The invention accordingly provides a downhole assembly for positioning a device within a drill string, the assembly comprising a hang-off means for securement in an upper drill string member, a lower connector means for location in a lower drill string member, and means interconnecting the hang-off means and the lower connector means, the device being mounted on the interconnecting means, and the interconnecting means including a shock absorber device connected between the device and the hang-off means.

Preferably, the lower connector means is locatable on an

inner barrel of a core barrel assembly, and may comprise a shoe fixed, in use, to said inner barrel and a stinger engaged in the shoe, the stinger and the shoe having an interfitting key and slot extending along the whole length thereof.

The shock absorber device is preferably connected between upper and lower rods forming part of said interconnecting means, and comprises a cylinder member secured to one of said rods, a piston member secured to the other of said rods, and compression spring means trapped between the cylinder member and the piston member. The spring means may suitably comprise a stack of Belleville washers.

The invention from another aspect also provides a hang-off device for use with a down-hole assembly, the device comprising a connecting rod for carrying a load and a latching carrier engagable with the upper end of the connecting rod; said upper end being formed with a taper face surmounted by a groove whose upper end defines a detent face; the latching carrier having a downwardly open orifice terminating in a matching taper for receiving said connecting rod upper end, and at least one latch pivotally mounted in a radial slot of the carrier with an inner face for engagement by said taper face to bring an upper face of the latch under said detent face.

Preferably the hang-off device includes lever means selectively connected with the or each latch and cooperable with a cam surface formed on the connecting rod.

Preferably, the downhole assembly of the invention includes the hang-off device as defined in the preceding two paragraphs.

From a further aspect, the invention resides in an apparatus for use in determining the alignment of the inner barrel of a core barrel assembly, the apparatus comprising a laser, means for rotatably mounting the laser on the inner core barrel with the axis of the laser parallel to the axis of the core barrel assembly, means for clamping said rotatable mounting means in a desired angular position, and a target means adapted to be mounted on the end of the assembly distant from the core barrel to intercept the laser beam.

Preferably, said target means comprises a radial arm mounted for rotation about the axis of the assembly.

Preferably also, the apparatus includes a protractor and means for clamping the protractor in a fixed position in relation to the inner core barrel said mounting means when rotated, traversing the protractor.

In a final aspect the invention provides a method of determining the alignment of a core barrel at the bottom of a downhole assembly, in which an axial laser beam is used to transfer a known angular position from the bottom to the top of each length of the downhole string as it is added

Embodiments of the invention will now be described, by way of example only, with reference to the drawings, in which:

Fig.1 is a somewhat schematic side view showing the general arrangement of a downhole assembly forming a first embodiment of the invention;

Fig.2 is a side view, the upper half in elevation and the lower half in cross-section, of a mule shoe used in the assembly of Fig.1;

Fig.3 is an end view of the mule shoe of Fig.2;

Fig.4 is a side view, partly in section, of a stinger used with the mule shoe;

Fig.5 is a section on A'-A" of Fig.4;

Fig.6 is a cross-sectional side view of a shock absorber assembly used in the downhole assembly of Fig.1;

Fig.7 is a cross-sectional side view of a hang-off assembly forming part of the down-hole assembly of Fig.1;

Fig.8 is a similar view showing a part of the assembly of Fig.7 in greater detail;

Fig. 9 is a schematic cross-sectional side view of a second embodiment of the invention; and

Fig. 10 is an end view of part of the apparatus of Fig. 9.

Referring to Fig.1, a drill string 10 terminates in a core barrel 12 comprising an outer barrel 14, which rotates with the drill string 10, and an inner barrel 16 which is connected to the outer barrel 14 by a bearing assembly generally indicated at 18 such that the inner barrel 16 is non-rotational.

The assembly of the present invention comprises a mule shoe 20 seated in the upper end of the inner barrel 16. A stinger 22 engages in the mule shoe 20 and is secured to one

end of an axial rod 24 which carries one or more electronics packages, one such being shown at 26. The other end of rod 24 is connected to a shock absorber assembly 28, from which a connecting rod 30 extends to a hang-off arrangement indicated at 32 by which the assembly is suspended within the drill string 10.

The electronics package 26 will typically include a magnetometer, and the assembly is therefore mounted within a drill collar 36 of a non-magnetic material such as monel.

Referring to Fig.2 and 3, the mule shoe 20 comprises an inner, generally cylindrical member 38 which is cut to provide an oblique planar end face 40 and an axial slot 42 extending along the whole length of the member 38. The member 38 is secured, e.g. by brazing at 44, within an outer member 46 which comprises a screw-threaded cylindrical portion 48 and an enlarged portion 50 with opposed flats 52. The mule shoe 20 can be secured to an inner core barrel by means of the screw threaded portion 48. Grooves 54,56 are provided for seals or the like.

The stinger 22, as seen in Fig.4 and 5, comprises a head 58 mounting a cylindrical probe 60. The head 58 has a screw-threaded socket 62 for attachment to the rod 24, and is formed with an oblique external face (not seen in Fig.4) at the same angle as the face 40 on the mule shoe 20 for abutment therewith. The probe 60 carries a longitudinal key 64 secured thereto by screws 66. The key 64 is dimensioned to slide axially within slot 42 in the mule shoe. Thus the rod 24 (Fig.1) is able to undergo substantial axial excursion with respect to the inner barrel 16 while remaining rotationally connected thereto.

The shock absorber assembly 28 is shown in detail in Fig.6.

The assembly comprises a lower tubular casing 68 and an upper tubular casing 70 screw-threadedly connected by a connector 72. The rod 24 is connected to the lower end of casing 68 by a coupling 73. An upper piston 74 slidable within the upper casing 70 has secured to it an extension piece 76 which is threaded at 78 for connection to the coupling rod 30. The upper piston 74 carries one or more keys 80 sliding in one or more corresponding slots in the casing 70 to prevent relative rotation.

The upper piston 74 is connected by a tie rod 82 to a lower piston 84 slidable within the casing 68. The pistons 74,84 may suitably be carried within the respective casings 70,68 by PTFE O-rings 86. The space between the lower piston 84 and the connector 72 is occupied by a compression spring in the form of a stack of Belleville spring washers. In a preferred arrangement, there are 126 such washers, each 31.5mm o.d. x 16.3mm i.d. x 1.75mm thk.

Thus, the assembly 28 acts to interpose a spring between the rods 24 and 30 to act as a shock absorber.

Referring to Fig.7, the non-magnetic drill collar 36 is formed at its upper end with a standard box thread 87 for a pin-and-box connection. Immediately inboard of this, the collar 36 is formed with a cavity 88 for receiving a bearing retainer 90 which mounts a ball bearing 92 abutted by a shoulder 94 on the connecting rod 30, and thus acting as a hang-off thrust bearing.

The bearing retainer 90 is shown in greater detail in Fig.8. It will be noted from Figs.8 and 9 that provision is made for the passage of drilling fluids via slots 96, annular groove 98, radial slots 100, and the annulus 102 between the lower end of the bearing retainer 90 and the adjacent part

of connecting rod 30.

Reverting to Fig.7, the upper part of the connecting rod 30 is formed to provide a taper 104, a neck 106 terminating in a detent face 108, and a part-spherical nose 110.

The downhole assembly can be run into place and recovered on a wireline by means of a latching carrier 112. The carrier has a lower orifice 114 tapered to engage with and centralise on the taper 104. A number of latches 116 (one only seen in Fig.7) are pivotally mounted in slots 118 such that an inner face 120 of latch 116 may be engaged by taper 104 for alignment therewith when the carrier 112 is fully home on taper 104 as shown.

When running the assembly into place, the assembly is hung on the carrier 112 with the latches 116 engaged under detent face 108. When the stinger 22 engages on the mule shoe 20, thus taking weight off the assembly, the carrier 112 tends to move downwardly with respect to the connecting rod 30. A lever secured to the latch 116 to pivot therewith, shown schematically at 122, has a lower end 124 acting as a cam follower on a cam face 126 formed on the connecting rod 30, and coacts therewith to rotate the latch into a vertical position thus limiting downward movement of the carrier 112 and allowing it to be removed upwardly.

To retrieve the downhole assembly, the lever 122 is removed from the carrier 112 which is then lowered by wireline. As the carrier 112 engages the upper end of connecting rod 30, the rounded nose 110 rotates the latch 116 to allow passage in the downward direction. The latch 116 is then rotated by contact with the taper 104 to engage under the detent face 108, thus allowing the wireline to retrieve the entire

downhole assembly down to and including the stinger 22.

The provision of the shock absorber cushions the electronics package against shock loads arising from drilling of the core, and also against shock loads arising from placing and retrieving the assembly. Forms of shock absorber other than the Belleville washer stack described could be used, for example a coil compression spring or a gas strut.

Referring now to Figs. 9 and 10, there will be described a second embodiment directed particularly to the problems of alignment discussed above.

A core barrel 130 is screw-threaded to a spacer 132 which is rotatable with respect to a drill collar 134 via a bearing assembly 136. A female mule shoe 138 is secured within the spacer 132.

An axial scribing blade 140 is mounted in the mouth of the core barrel 130, so as to scribe an axial mark on a core as it is received within the barrel. The apparatus now to be described allows a mark to be made to the opposite end of the drill collar 134 in alignment with, or at a known angle with respect to, the scribing blade 140.

A laser 142 is secured via a post 144 to a ring 146 dimensioned to be rotatable on the exterior of the core barrel 130. The ring 146 may be clamped in any desired angular position, for example by a clamping bolt 148. The laser may thus be aligned with the blade 140, and then a radial target arm 150 at the opposite end of the assembly brought into precise alignment with the blade 140 by being rotated to intercept the laser beam. An alignment mark is then scribed on the upper end of the drill collar 134.

Thus, when the assembly shown is lowered into borehole, the scribed mark is available at the drill floor and known to be in alignment with the scribing blade 140. A similar procedure, using a larger mounting ring for the laser, can then be used to transfer the marking from bottom to top of each stand of drill pipe as it is added to the string.

As shown in Fig. 9, it is convenient to mount the target 150 rotatably on an axial stringer 152 received in the mule shoe 138, thus giving a convenient axial mount.

There can be situations where there is insufficient room to bring the laser 142 directly into alignment with the scribing blade 140. In this event, a protractor 154 may be clamped to the core barrel and the laser 142 set at an angle to the scribing blade, as indicated in dashed lines in Fig. 10. The magnitude of this angle can be read off against the protractor by eye, and allowed for when reading the core drilled.

We have found that owing to its inertia the core barrel does not rotate with respect to the drill string until bottom is reached and drilling of the core starts, and thus the known orientation remains valid. If, however, there were a tendency for relative rotation to occur while the assembly is being placed down hole, the core barrel could be held in angular position until drilling of the core commences by means such as a sprung detent or a latch remotely operated by cable or mud pressure.

Modifications may be made to the foregoing embodiments within the scope of the present invention.

CLAIMS

1. A downhole assembly for positioning a device within a drill string, the assembly comprising a hang-off means for securement in an upper drill string member, a lower connector means for location in a lower drill string member, and means interconnecting the hang-off means and the lower connector means, the device being mounted on the interconnecting means, and the interconnecting means including a shock absorber device connected between the device and the hang-off means.

2. A downhole assembly as claimed in Claim 1, wherein the lower connector means is locatable on an inner barrel of a core barrel assembly, and may comprise a shoe fixed, in use, to said inner barrel and a stinger engaged in the shoe, the stinger and the shoe having an interfitting key and slot extending along the whole length thereof.

3. A downhole assembly as claimed in Claim 1 or 2, wherein the shock absorber device is connected between upper and lower rods forming part of said interconnecting means, and comprises a cylinder member secured to one of said rods, a piston member secured to the other of said rods, and compression spring means trapped between the cylinder member and the piston member.

4. A downhole assembly as claimed in Claim 3, wherein the spring means comprises a stack of Belleville washers.

5. A hang-off device for use with a down-hole assembly as claimed in any one of Claims 1 to 4, the device comprising a connecting rod for carrying a load and a latching carrier engagable with the upper end of the connecting rod; said

engagable with the upper end of the connecting rod; said upper end being formed with a taper face surmounted by a groove whose upper end defines a detent face; the latching carrier having a downwardly open orifice terminating in a matching taper for receiving said connecting rod upper end, and at least one latch pivotally mounted in a radial slot of the carrier with an inner face for engagement by said taper face to bring an upper face of the latch under said detent face.

6. A hang-off device as claimed in Claim 5, including lever means selectively connected with the or each latch and cooperable with a cam surface formed on the connecting rod.

7. A downhole assembly as claimed in any one of Claims 1 to 4 and including a hang-off device as defined in Claim 5 or 6.

8. Apparatus for use in determining the alignment of the inner barrel of a core barrel assembly, the apparatus comprising a laser, means for rotatably mounting the laser on the inner core barrel with the axis of the laser parallel to the axis of the core barrel assembly, means for clamping said rotatable mounting means in a desired angular position, and a target means adapted to be mounted on the end of the assembly distant from the core barrel to intercept the laser beam.

9. Apparatus as claimed in Claim 8, wherein the target means comprises a radial arm mounted for rotation about the axis of the assembly.

10. Apparatus as claimed in Claim 8 or 9, including a protractor and means for clamping the protractor in a fixed position in relation to the inner core barrel said mounting

means when rotated, traversing the protractor.

11. A method of determining the alignment of a core barrel at the bottom of a downhole assembly, in which an axial laser beam is used to transfer a known angular position from the bottom to the top of each length of the downhole string as it is added.

12. A downhole assembly substantially as hereinbefore described, with reference to and as shown in Figs. 1 to 6 of the accompanying drawings.

13. A hang-off device for use with a downhole assembly substantially as hereinbefore described with reference to and as shown in Figs. 7 and 8 of the accompanying drawings.

14. Apparatus for use in determining the alignment of the inner barrel of a core barrel assembly substantially as hereinbefore described, with reference to and as shown in Figs. 9 and 10 of the accompanying drawings.

15. A method of determining the alignment of a core barrel at the bottom of a downhole assembly substantially as hereinbefore described.

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